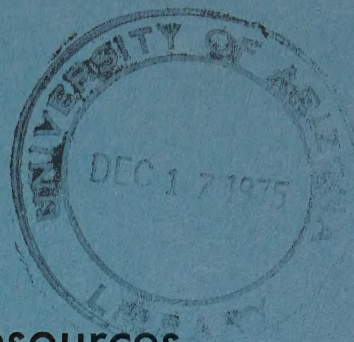




ONTARIO
DEPARTMENT OF MINES



Industrial Mineral Resources of the Brampton Area

By
D. F. HEWITT

Industrial Mineral Report 23

1969

557.1
059
#23

COMPLIMENTARY COPY



ONTARIO
DEPARTMENT OF MINES

HON. ALLAN F. LAWRENCE, *Minister of Mines*

D. P. DOUGLASS, *Deputy Minister*

J. E. THOMSON, *Director, Geological Branch*

Industrial Mineral Resources
of the
Brampton Area

Halton, Peel, and York Counties

By
D. F. HEWITT

Industrial Mineral Report 23

TORONTO

1969

Crown copyrights reserved. This book may not be reproduced, in whole or in part, without the permission of the Ontario Department of Mines.

Publications of the Ontario Department of Mines

and pricelist

are obtainable through the

Publications Office, Ontario Department of Mines

Parliament Buildings, Toronto, Ontario, Canada.

Orders for publications should be accompanied by cheque, or money order, payable to Treasurer of Ontario. Stamps are not acceptable.

CONTENTS

	PAGE
Abstract	vi
Introduction	1
Mineral Production	2
Access	2
Topography	2
Drainage	2
Previous Work	3
Field Work	3
Acknowledgments	3
Paleozoic Geology	3
Table of Formations	3
Ordovician	3
Meaford-Dundas Shale	3
Ceramic Properties of the Dundas Shale	4
Mineral Composition of the Dundas Shale	4
Chemical Composition of the Dundas Shale	4
Utilization of the Dundas Shale	4
Queenston Shale	4
Ceramic Properties of the Queenston Shale	4
Mineral Composition of the Queenston Shale	5
Chemical Composition of the Queenston Shale	5
Utilization of the Queenston Shale	5
Silurian	5
Cataract Group	5
Whirlpool Sandstone	5
Manitoulin Dolomite	5
Cabot Head Shale and Sandstone	6
Clinton Group	6
Reynales Dolomite	6
Albemarle Group	6
Amabel Dolomite	6
Cenozoic	6
Pleistocene Geology	6
Glacial History	6
Physiographic Features	7
Niagara Escarpment	7
Halton-Peel Till Plain	7
Lake Iroquois Shoreline	7
Pleistocene Deposits	7
Till Plains	7
Drumlins	8
Moraines	8
Outwash and Spillway Deposits	8
Kames	8
Eskers	8
Lake Plains	8
Pleistocene Stratigraphy	8
Recent Deposits	8
Economic Geology	9
Dundas Shale	9
Booth Brick Limited (2)	9
Etobicoke Plant	9
Booth Brick Limited (3)	9
North York Plant	9
Domtar Construction Materials Limited (5)	9
Cooksville Plant	9
Ontario Reformatory (9)	9
Queenston Shale	9
Brampton Brick Limited (1)	9
Canada Brick Limited (4)	9
Streetsville	9
Domtar Construction Materials Limited (6)	10
Cheltenham Plant	10
McFarren, F. B., Limited (7)	10
Milton Brick Limited (8)	10
Toronto Brick Company (10)	10

	PAGE
Whirlpool Sandstone	10
Barnes, William R., Company Limited (11)	10
Brockton Quarry (12)	11
Cohoon Quarry (13)	11
Corner's, Austin, Quarry (14)	11
Credit Valley Quarries (15)	11
Handy, D. (16)	11
Hilltop Quarry, Primeau Argo Block Company (17)	11
Martin Quarry (18)	12
Morgan Stone Company (19)	12
Norton, Harvey (20)	12
Rice and McHarg Quarry (21)	12
Skelin, S. (22)	12
Skelin, S. (23)	12
Smithson Quarry (24)	13
Structural Sandstone Quarry (25)	13
Amabel Dolomite	13
Armstrong Brothers Company Limited (26)	13
Georgetown Quarry	13
Domtar Chemicals Limited (27)	13
Milton Plant and Quarry	13
Dufferin Quarry (28)	13
Halton Crushed Stone Limited (29)	14
Industrial Sand and Gravel Company Limited (30)	14
Glen Williams Quarry	14
Limehouse Crushed Stone and Gravel Limited (31)	14
Milton Quarries Limited (32)	15
Sand and Gravel	15
Ace Sand and Gravel (33)	15
Alrex Sand and Gravel (34)	15
Armstrong Brothers Company Limited (36)	15
Glen Williams	15
Bee Jay Sand and Gravel (38)	15
Glen Williams	15
Bee Jay Sand and Gravel (39)	15
Terra Cotta	15
Brampton Esker	15
Peel Sand and Gravel (58)	16
Brooks Pit (40)	16
Clarkson Sand and Gravel (42)	16
Connor Transport Limited (43)	16
Consolidated Sand and Gravel Limited (44)	16
Malton	16
Consolidated Sand and Gravel Limited (45)	16
Stewartown	16
Franceschini Brothers Construction Company Limited (48)	16
Britannia	16
Franceschini Brothers Construction Company Limited (49)	16
Erindale	16
Greenley, W. R., Construction Company (51)	17
Industrial Sand and Gravel (52)	17
Lot 5, Concession VIII, Esquesing Township (54)	17
Lot 11, Concession IV, Esquesing Township (55)	17
Mineral Industries Sand and Gravel Limited (56)	17
Oriole Block Company (57)	17
Peel Sand and Gravel (58)	17
Pinchin, R. (59)	17
Sherman Sand and Gravel Limited (60)	17
Clarkson	17
Sherman Sand and Gravel Limited (61)	17
Glen Williams	17
Sherman Sand and Gravel (62)	18
Huttonsville	18
Sherman Sand and Gravel (63)	18
Kelso	18
References	19
Index	20

Tables

1-Production data for Industrial Minerals in the Brampton area for 1965	2
2-Table of Formations	3
3-Ceramic properties of the Dundas Shale	4
4-Chemical composition of the Dundas Shale	4
5-Ceramic properties of the Queenston Shale	4
6-Chemical composition of the Queenston Shale	5
7-Physical properties of a specimen of Whirlpool Sandstone	5
8-Chemical analysis of silica sand produced from crushing Whirlpool Sandstone	10
9-Physical properties of a specimen of grey Whirlpool Sandstone, property 14	11
10-Physical properties of grey Whirlpool Sandstone, property 17	12
11-Physical specifications of grey Whirlpool Sandstone, property 21	12
12-Chemical analysis of composite chip sample from property 26	13
13-Chemical analysis of stone from property 28	13
14-Chemical analyses of stone from property 29	14
15-Chemical analysis of stone from property 32	15
16-Sieve analysis of sand from property 55	17
17-Sieve analysis of sand from property 61	18
18-Sieve analysis of sand from property 62	18

Figure

1-Key map showing location of map-area	vi
--	----

Geological Maps (back pocket)

- Map 2176 (coloured)-Brampton area, southern Ontario, Industrial Mineral Resources Sheet.
Scale, 1 inch to 1 mile.
- Map 2179 (coloured)-Brampton area, southern Ontario, Drift Thickness Map.
Scale, 1 inch to 1 mile.

ABSTRACT

The Brampton area sheet is one of a series of 1 inch to 1 mile maps showing the industrial mineral resources of the area, including bedrock outcrops, surficial deposits, and mineral properties. The Brampton area comprises the Brampton topographic sheet extending between Latitudes $43^{\circ}30'N$ and $43^{\circ}45'N$ and Longitudes $79^{\circ}30'W$ and $80^{\circ}00'W$.



Figure 1—Key map showing location of map-area.
Scale, 1 inch to 50 miles.

The Niagara Escarpment extends up the west side of the area; it is capped by the Amabel Dolomite, which is quarried for crushed stone. Rocks of the Clinton and Cataract Groups lie beneath the Amabel Dolomite in the face of the Escarpment, but with the exception of the basal Whirlpool Sandstone, they are not well exposed in the map-area. The Whirlpool Sandstone, which is the basal unit of the Silurian rocks of this area, outcrops as a minor scarp at the base of the Niagara Escarpment and is quarried as a building stone at Milton, Limehouse, Glen Williams, and Terra Cotta.

Below the Whirlpool Sandstone lies the red Queenston Shale of Ordovician age, which is quarried for brick manufacture at Milton, Brampton, and Streetsville. Below the Queenston Shale lies the Meaford-Dundas Shale that is also quarried for brick manufacture at Cooksville and Etobicoke.

Sand and gravel are abundant in the area.

Industrial Mineral Resources of the BRAMPTON AREA

Halton, Peel, and York
Counties

by
D. F. Hewitt¹

INTRODUCTION

The Brampton area sheet is one of a series of 1 inch to 1 mile maps showing the industrial mineral resources including bedrock outcrops, surficial deposits, and mineral properties in the area. The Brampton area comprises the Brampton topographic sheet extending between Latitudes $43^{\circ}30'N$ and $43^{\circ}45'N$ and Longitudes $79^{\circ}30'W$ and $80^{\circ}00'W$. This includes portions or all of the townships of Esquesing, Erin, Chinguacousy, Toronto, Nelson (now Town of Burlington), Etobicoke, York, Trafalgar (now Town of Oakville), Nassagaweya, and Toronto Gore. The principal municipalities, towns, and villages are Brampton (35,739)², Georgetown (12,617)², Milton (6,421)², Streetsville (6,123)², Port Credit (8,089)², Malton, Cooksville, Clarkson, Erindale, and part of Metropolitan Toronto.

Overburden is of moderate thickness (Map 2179, back pocket, shows drift thicknesses), and outcrops are abundant in some areas, particularly along the Niagara Escarpment and in the river valleys. The Niagara Escarpment extends along the western edge of the Brampton map-area, west of Milton and Georgetown, and is the most noteworthy topographic feature of the area. On top of the Escarpment, west of Milton, elevations range up to 1,125 feet above sea level. At the foot of the Escarpment elevations average 725 to 750 feet giving a relief for the Escarpment of about 400 feet in this area. The cap rock of

the Niagara Escarpment in the Brampton map-area is the Amabel Dolomite of Silurian age. This formation outcrops extensively along the brow of the Escarpment and is quarried for building stone at Milton by Milton Quarries Limited, Halton Crushed Stone Limited, and the Dufferin quarry. It was formerly quarried near Georgetown by Armstrong Brothers Company Limited, Limehouse Crushed Stone and Gravel Limited, and Industrial Sand and Gravel Company Limited. A large quarry is operated just north of the map-area by Acton Limestone Quarries Limited.

Rocks of the Clinton and Cataract Group lie beneath the Amabel Dolomite, in the face of the Escarpment, but with the exception of the basal Whirlpool Sandstone, they are not well exposed in most places in the map-area. The Whirlpool Sandstone, which is the basal unit of the Silurian rocks of this area, outcrops rather extensively as a minor scarp at the base of the Niagara Escarpment and is quarried at Milton, Limehouse, Glen Williams, and Terra Cotta as a building stone.

Below the Whirlpool Sandstone lies the red Queenston Shale of Ordovician age. This shale is exposed in many places at the base of the Escarpment and is, in places, heavily eroded and sustains no vegetation. The upper weathered portion of the Queenston Shale is prized as a material of high plas-

¹Senior Geologist, Industrial Minerals Section, Ontario Department of Mines, Toronto.
Manuscript accepted for publication by the Director, Geological Branch, 20 February, 1967.

²Population data for 1968.

ticity for brick and tile manufacture. Queenston Shale is quarried for the manufacture of brick by Canada Brick Limited and F. B. McFarren Limited at Streetsville, Brampton Brick Limited at Brampton, and Milton Brick Limited at Milton. It was formerly quarried at Cheltenham by Domtar Construction Materials Limited and at Milton by Toronto Brick Company Limited. Although outcrops of Queenston Shale are abundant along the base of the Escarpment, they are rare to the eastward except in river and creek valleys.

Below the Queenston Shale lies the blue-grey Meaford-Dundas Shale of Ordovician age. This outcrops sparingly in river and creek beds. The Dundas Shale is quarried for the manufacture of brick at the Cooksville plant of Domtar Construction Materials Limited, the Ontario Reformatory, and Booth Brick's Etobicoke plant. The shale for Booth Brick's North York plant is quarried at the Etobicoke plant. A lightweight aggregate called Haydite is manufactured from Dundas Shale at the Cooksville plant of Domtar Construction Materials Limited.

The Pleistocene deposits on top of the Escarpment consist predominantly of stony and bouldery till containing many blocks of Amabel Dolomite. Below the Escarpment the area is mantled by clay till except along and south of the Iroquois beach. The ancient beach of Glacial Lake Iroquois extends from Sheridan, southwest of Clarkson, in a north-northeasterly direction through Clarkson, Erindale, Cooksville, Dixie, and Summerville into Etobicoke. A gravel bar on the Lake Iroquois shore in the vicinity of Erindale has been extensively worked for sand and gravel. Other sand pits have been worked farther to the northeast along the Iroquois beach. Much of the area between the Iroquois beach and the present lakeshore is sandy.

Other prominent glacial features in the area are the Georgetown spillway, the Brampton esker, and the Woodhill buried kame.

MINERAL PRODUCTION

Mineral production in the area consists of sand and gravel, brick and tile, sandstone building stone, and crushed stone. In 1965, the mineral production of the area amounted to \$17,523,810, divided as shown in Table 1.

Table 1 PRODUCTION DATA FOR INDUSTRIAL MINERALS IN THE BRAMPTON AREA FOR 1965

Product	Number of Operators	Value
Sand and gravel	19	\$ 3,612,136
Brick and tile	9	11,228,770
Sandstone building stone	5	483,903
Crushed stone	3	2,199,001
Total		\$17,523,810

In 1966, twenty-three sand and gravel pits were visited; of these, eight reported production. Nine brick and tile companies were in operation. Twelve sandstone quarries were visited of which five reported production. Six crushed stone quarries were visited of which three were in production.

ACCESS

A grid of roads, at approximately 1 mile intervals, crosses the map-area providing excellent access to the entire area. Provincial Highways 2, 5, 7, 10, 25, 401 (MacDonald-Cartier Freeway), and the Queen Elizabeth Way, as well as several paved county roads cross the area.

TOPOGRAPHY

The maximum elevation is 1,300 feet above sea level, on the top of the Escarpment in Erin Township in the northwest corner of the area. The elevation of the top of the Escarpment decreases towards the south and is about 1,000 feet west of Milton. The till plain below the Escarpment has an elevation of 925 feet near Cheltenham and descends to about 475 feet near Thistletown. Elevations in the Humber River valley at Thistletown approach 425 feet.

From Cheltenham, in the north, the till plain slopes gently to the south to Milton where the elevation is 625 feet. Again the land slopes gently to the eastward with elevations of 275 feet at Long Branch and 250 feet along the lakeshore at Port Credit.

The Iroquois beach is at a level of approximately 375 feet at Sheridan, 400 feet near Cooksville, and 425 feet near Scarlett Road.

DRAINAGE

The area drains into Lake Ontario via Oakville Creek, the Credit River, Fletchers Creek, Cooksville Creek, Etobicoke Creek, Mimico Creek, and the Humber River. The Claireville dam on the Humber River is in the northeastern part of the area. Although the banks of Middle Oakville Creek are mainly cut in till, there are good exposures of Queenston Shale 1 and 2 miles south of Drumquin. The Credit River occupies the Georgetown spillway from Cheltenham to Glen Williams. Outcrops of Queenston Shale occur along the Credit River at Georgetown and Huttonsville. From Streetsville to Lake Ontario there are numerous riverside cuts of Meaford-Dundas Shale. Along Etobicoke Creek, Queenston Shale is exposed southeast of Brampton for 1½ miles. On the Second Line East of Toronto Township, Meaford-Dundas Shale outcrops in the banks of Etobicoke Creek. Other outcrops of

Meaford-Dundas Shale along the creek banks occur east of Mount Charles and north and south of Highway 401 (MacDonald-Cartier Freeway).

PREVIOUS WORK

The bedrock geology of the area is described by Caley (1940). The Pleistocene geology of parts of the area is described by Coleman (1932; 1936a and b). Some unpublished Pleistocene mapping in Etobicoke, Toronto, and Chinguacousy Townships has been done by A. K. Watt for the Ontario Department of Mines. A good general description of the physiography is given by Chapman and Putnam (1951). This latter book includes a generalized surficial geologic map on the scale of approximately 1 inch to 4 miles. A useful publication on the surficial geology of Peel County is the Soil Survey of Peel County, Soil Survey Report No. 18, Hoffman and Richards (1953). Sand and

gravel deposits are described by Hewitt and Karrow (1963). Crushed stone deposits are described by Hewitt (1960; 1964a). The Whirlpool Sandstone quarries are described by Hewitt (1964b). The brick and tile plants are described by Guillet (1967). The geology of the Niagara Escarpment is described by Bolton (1957).

FIELD WORK

Field work for this report was carried out during part of the summer of 1966 by the author.

ACKNOWLEDGMENTS

The writer is indebted to Mr. A. K. Watt of the Ontario Water Resources Commission for some information on Etobicoke, Toronto, and Chinguacousy Townships.

PALEOZOIC GEOLOGY

The bedrock formations in the Brampton area are shown in Table 2.

ORDOVICIAN Meaford-Dundas Shale

The Meaford-Dundas Shale underlies the eastern part of the Brampton area east of Brampton and Streetsville to the eastern edge of the map-area. The Meaford-Dundas Shale consists of thin- to medium-bedded, grey-green shale interlayered with grey beds of limestone or calcareous sandstone up to 6 inches thick. These hard layers are sorted out and used as a building stone at the Cooksville quarry of Domtar Construction Materials Limited. The contact between the grey Meaford Shale and the overlying red Queens-

ton Shale is gradational over about 10 feet. It can be observed at the quarry of F. B. McFarren Limited in Streetsville. The Meaford Shale is indistinguishable lithologically from the underlying Dundas Shale so these two formations are grouped together.

The Meaford Shale has a thickness of about 115 feet and may be seen outcropping in the Credit River valley below Streetsville (Caley 1940, p. 17). The Dundas Shale is approximately 400 feet thick and consists, in ascending order, of the Rosedale Member, the Danforth Member, the Humber Member, and the Credit Member; all of which are only distinguishable on faunal evidence. The Humber Member is present in the quarries of Booth Brick Limited and the Ontario Reformatory in Etobicoke, and the Cooksville quarry of Domtar Construction Materials Limited.

Table 2 TABLE OF FORMATIONS			
ERA	PERIOD	GROUP	FORMATION
Paleozoic	Silurian	Albemarle Clinton Cataract	Amabel Dolomite Reynales Dolomite Cabot Head Shale and Sandstone Manitoulin Dolomite* Whirlpool Sandstone
	Ordovician		Queenston Shale Meaford-Dundas Shale
* In the Brampton and Bolton areas this rock is dolomitic limestone.			

Hard layers make up 10 to 20 percent of the shale section. The hard layers frequently weather rusty adding to their attractiveness as a building stone. These rusty hard limestone layers may be seen in many buildings in Toronto where they give a very effective contrast with the non-rusty limestone. An example of the use of this rusty Dundas limestone is St. Clement's Anglican Church on Duplex Avenue in Toronto.

Ceramic Properties of the Dundas Shale. Details on the ceramic properties of the Dundas Shale, in Table 3, are taken from Guillet (1967). The Dundas Shale has just sufficient workability for modern extrusion equipment. It burns red and has a short firing range.

Table 3 CERAMIC PROPERTIES OF THE DUNDAS SHALE (FROM GUILLET 1967, P. 34)

Water plasticity (percent)	18		
Lineal drying shrinkage (percent)	2.3		
Pyrometric cone equivalent	5		
	Cones		
	010	06	03
	(1660°F)	(1840°F)	(1980°F)
Lineal firing shrinkage (%)	0.1	0.6	2.4
24-hour cold water absorption (%)	13.1	11.7	4.3
5-hour boil absorption (%)	14.6	13.8	6.8

Mineral Composition of the Dundas Shale. The average clay content is about 60 percent with illite the most abundant clay mineral and chlorite present in moderate amounts.

Chemical Composition of the Dundas Shale. Table 4 shows the average chemical composition of the Dundas Shale.

Table 4 CHEMICAL COMPOSITION OF THE DUNDAS SHALE (FROM GUILLET 1967, P. 35)

	Average Analysis	Pure Dundas Shale	Limy Layer	Sandy Layer
	(percent)	(percent)	(percent)	(percent)
SiO ₂	55.66	58.74	34.7	63.6
Al ₂ O ₃	15.3	17.90	9.0	15.0
Fe ₂ O ₃	6.60	7.50		
CaO	4.63	2.37	30.3	7.3
MgO	2.82	2.84	trace	trace
Na ₂ O	0.93	4.03	...	...
K ₂ O	3.51			
TiO ₂	0.89	...	...	...
CO ₂	4.06	8.26	24.7	9.3
H ₂ O +	3.38			
H ₂ O -	1.00	...	...	...
SO ₃	0.78	...	...	...
Totals	99.6	101.64	98.7	95.2

Utilization of the Dundas Shale. Dundas Shale is quarried for the manufacture of brick at the Cooksville plant of Domtar Construction Materials Limited and the Etobicoke plants of Booth Brick Limited and the Ontario Reformatory.

Queenston Shale

The Queenston Shale underlies a large part of the Brampton area extending from the base of the Niagara Escarpment eastward to east of Brampton and Streetsville. The formation is Upper Ordovician in age and consists of brick red, thinly bedded, fissile shale with interbeds of greenish sandy or limy layers. Within the red shale sequence are seams and bands of green shale following bedding planes or crosscutting the sequence along fractures. Round or oval green "eyes" are commonly seen in the red shale and these sometimes have centres of calcite or carbonaceous material.

In the Brampton area the Queenston Shale is 440 to 500 feet thick, thinning to the north. It is overlain by the Whirlpool Sandstone of Silurian age and underlain by the grey Meaford-Dundas Shale. Queenston Shale readily breaks down under weathering processes to form a red clay soil, which is characteristic of the area below the Niagara Escarpment as seen at Georgetown, Glen Williams, and Terra Cotta.

Ceramic Properties of the Queenston Shale. Details on the ceramic properties of the Queenston Shale are taken from Guillet (1967) and shown in Table 5.

Table 5 CERAMIC PROPERTIES OF THE QUEENSTON SHALE (FROM GUILLET 1967, P. 58)

UNWEATHERED SHALE			
Water of plasticity (percent)	17		
Lineal drying shrinkage (percent)	3.2		
Pyrometric cone equivalent	4		
	Cones		
	010	06	03
	(1660°F)	(1840°F)	(1980°F)
Lineal firing shrinkage (%)	0	0	0.9
24-hour cold water absorption (%)	13.4	12.3	8.5
5-hour boil absorption (%)	14.2	15.2	11.5
WEATHERED SHALE			
Water of plasticity (percent)	20		
Lineal drying shrinkage (percent)	3.8		
Pyrometric cone equivalent	5		
	Cones		
	010	06	03
	(1660°F)	(1840°F)	(1980°F)
Lineal firing shrinkage (%)	0.5	2.1	3.5
24-hour cold water absorption (%)	12.1	9.0	4.0
5-hour boil absorption (%)	13.5	11.0	5.5

Unweathered Queenston Shale has a fairly short firing range and a light red fired colour. The depth of colour varies with the proportion of green shale present. The green shale by itself is buff-burning being high in lime content. Weathered Queenston Shale has a longer firing range and a deeper red fired colour.

Mineral Composition of the Queenston Shale. The Queenston Shale consists 60 percent of clay minerals and 40 percent of non-clay minerals. Illite is the most abundant clay mineral; chlorite occurs in moderate amounts. Quartz, feldspar, and carbonates are among the non-clay fraction. Gypsum is sometimes present as sheets or nodules.

Chemical Composition of the Queenston Shale. The chemical composition of the Queenston Shale is taken from Guillet (1967) and is shown in Table 6.

Table 6	CHEMICAL COMPOSITION OF THE QUEENSTON SHALE (FROM GUILLET 1967, P. 58)	
	Unweathered shale	Weathered shale
	(percent)	(percent)
SiO ₂	51.28	56.28
Al ₂ O ₃	13.9	16.0
Fe ₂ O ₃	6.15	6.77
CaO	9.00	4.74
MgO	3.48	2.55
Na ₂ O	0.58	0.70
K ₂ O	3.60	3.93
TiO ₂	0.72	0.85
CO ₂	7.29	3.81
H ₂ O +	2.73	3.21
H ₂ O -	0.80	0.92
SO ₃	0.26	0.33
Totals	99.8	100.1

Utilization of the Queenston Shale. Queenston Shale is quarried for the manufacture of brick by Canada Brick Limited and F. B. McFarren Limited at Streetsville, Brampton Brick Limited at Brampton, and Milton Brick Limited at Milton.

SILURIAN

CATARACT GROUP

Whirlpool Sandstone

The basal formation of the Silurian System is the Whirlpool Sandstone, which outcrops along the base of the Niagara Escarpment. Its thickness varies from 10 to 15 feet. It is a thin- to massive-bedded, medium- to fine-grained, grey to red, crossbedded, compact, unfossiliferous quartzose sandstone. The Whirlpool Sandstone rests unconformably on the Queenston Shale and is overlain by the Manitoulin Dolomite.

The Whirlpool Sandstone is widely quarried from Milton to Cheltenham in the map-area as a building stone under the trade name of "Credit Valley Sandstone". Wm. R. Barnes Company Limited, at Milton, quarries the sandstone for refractory purposes. In 1966, the following operators quarried "Credit Valley Sandstone" as a building stone: S. Skelin, Brockton quarry, Morgan Stone Company, D. Handy, Rice and McHarg quarry, Harvey Norton, Primeau Argo Block Company (Hilltop quarry), and Austin Corner's quarry. Quarries were formerly operated by Ed. Martin, Smithson, and A. Zilio (Credit Valley Quarries, property 15). The major products produced are ashlar coursing stone, sills, steps, copings, flagstone, and dry wall stone.

Physical properties of a specimen of grey Whirlpool Sandstone from the Hilltop quarry of Primeau Argo Block Company are shown in Table 7.

Table 7	PHYSICAL PROPERTIES OF A SPECIMEN OF WHIRLPOOL SANDSTONE FROM HILLTOP QUARRY; ANALYSIS BY LABORATORY AND RESEARCH BRANCH, ONTARIO DEPT. MINES	
Compressive strength, p.s.i.:	Maximum	17,500
	Minimum	12,650
	Average	15,433
Absorption:		2.81 percent
Bulk specific gravity:		2.34
Weight per cubic foot:		146 pounds
Abrasive hardness:		12.5

The "Credit Valley Sandstone" is widely used as a building stone in the Toronto area and may be seen in the main building of the Parliament Buildings, the Royal Ontario Museum, Knox College, and many other buildings.

Manitoulin Dolomite

Underlying the Cabot Head Shale, in the face of the Niagara Escarpment, is the Manitoulin Dolomite, a formation about 11 to 15 feet thick (Bolton 1957, p. 15). The Manitoulin Dolomite consists of thin- to medium-bedded, blue-grey, buff-weathering, fine- to medium-crystalline dolomite with shaly partings. The contact between the Cabot Head Shale and the Manitoulin Dolomite is gradational through a few feet of interbedded shale and dolomite. The Manitoulin Dolomite outcrops sparingly along the Escarpment and is not shown on Map 2176 (back pocket); it is best seen above the Whirlpool Sandstone at the Wm. R. Barnes Company Limited quarry (property 11). There are good exposures north of the map-area at the Inglewood quarries where considerable stripping of the Manitoulin Dolomite and Cabot Head Shale and Sandstone above the Whirlpool Sandstone has taken place.

Cabot Head Shale and Sandstone

Outcropping sparingly in the face of the Niagara Escarpment under the Reynales Dolomite are about 35 feet of Cabot Head Shale and Sandstone; neither the Reynales nor the Cabot Head are shown on Map 2176 (back pocket). The thin-bedded fissile shale is grey-green in colour. There are thin interbeds of grey-to rusty-weathering, dense calcareous sandstone and limestone. Bolton (1957, p. 17) reports some thin beds of red sandstone and shale in the upper 12 to 13 feet of the Cabot Head Formation, which may represent early advances of the southern Grimsby facies into the section. In places, in the Brampton area, the upper parts of the Cabot Head Formation resemble the Thorold Formation.

CLINTON GROUP

Reynales Dolomite

The Reynales Dolomite, which underlies the Amabel Dolomite in the Brampton area, has a thickness of approximately 8 feet. It is a medium grey to grey, mottled to streaky, buff-weathering, aphanitic, medium-bedded dolomite easily distinguished from the overlying medium-crystalline Amabel Dolomite. This rock forms the floor at Milton Quarries Limited, Halton Crushed Stone Limited, Dufferin quarry, and Armstrong Brothers' Georgetown quarry. A few feet of this stone form a much more solid floor than the underlying Cabot Head Shale and Sandstone.

ALBEMARLE GROUP

Amabel Dolomite

Within the Brampton area, the cap rock of the Niagara Escarpment is the Amabel Dolomite, a reefy, medium-crystalline, highly fossiliferous, light buff, medium- to massive-bedded dolomite, which extends from Waterdown through Milton, Georgetown, and Acton to the Bruce Peninsula. The Amabel Dolomite is the lateral equivalent of the Lockport Dolomite of the Niagara Falls-Dundas section of the Escarpment.

In the Brampton area, the Amabel Formation is not divisible into members but consists wholly of light grey to buff, buff-weathering, medium to coarsely crystalline, massive to irregularly bedded and reefy fossiliferous dolomite. The maximum thickness exposed at one place is 84 feet at the old Milton quarry of Domtar Construction Materials Limited. The total thickness of Amabel Dolomite probably exceeds 130 feet. The Amabel Formation rocks are generally of high chemical purity and qualify as high-purity dolomite.

The dolomite is principally quarried as crushed stone for concrete aggregate and road stone. Its soundness, absorption, and abrasion qualities make it suitable for these uses. Los Angeles abrasion tests range from 21 to 35 percent loss, indicating the rock is generally rather soft. $MgSO_4$ soundness ranges from 2 to 9 percent loss. The stone is sound. Absorption ranges from 0.4 to 1.6 percent. In the Milton area it is quarried by Milton Quarries Limited, Halton Crushed Stone Limited, and the Dufferin quarry of Associated Quarries and Construction Limited¹. It was previously quarried at Milton Heights by the former Gypsum Lime and Alabastine Company for the manufacture of dolomitic lime. The old kilns still stand on the side of the Escarpment above the Canadian Pacific Railway track. The Amabel Dolomite is quarried intermittently at the Georgetown quarry of Armstrong Brothers Company Limited, and was formerly quarried near Georgetown by Limehouse Crushed Stone and Gravel Limited and near Glen Williams by Industrial Sand and Gravel Company Limited. These latter two quarries are now closed.

In the Bruce Peninsula, Bolton (1957, p. 51-57) divided the Amabel Formation into four members: Lions Head, Colpoys Bay, Wiarton, and Eramosa; however, in the Brampton area the formation is remarkably uniform except for reefy zones. No chert or sulphide mineralization was noted, although rusty patches are sometimes present.

At its lower contact the Amabel Dolomite rests on the Reynales Dolomite.

CENOZOIC

PLEISTOCENE GEOLOGY

Glacial History

Field work in the Toronto area has indicated that glacial ice sheets spread over southern Ontario during the Illinoian and Wisconsinan glacial stages. The last ice sheet to spread over Ontario was called the Wis-

consin ice sheet and all of the Pleistocene deposits in the Brampton area are associated with the advance and retreat of this ice sheet. By 27,000 years ago the last major ice advance was under way and by 20,000 years ago the ice had spread to its maximum extent, reaching southern Ohio. As far as is known, all of southern Ontario was covered by glacial ice until

¹Name changed to Dufferin Materials and Construction Limited.

about 14,000 years ago when a retreat of the ice fronts began. As the ice retreated one ice lobe occupied the Lake Ontario basin and another lobe occupied the Lake Simcoe basin.

As the Lake Ontario ice lobe retreated from the Niagara Escarpment, glacial spillways formed between the Escarpment and the ice lobe. The Georgetown spillway and the spillways around Campbellville¹ were probably formed at this time.

As the ice lobes retreated, the Lake Ontario lobe held a glacial lake ponded against the southern side of the Oak Ridges² moraine. This is called the "Peel ponding" by Chapman and Putnam (1951) and Lake Peel by Karrow (1963, p. 18). Thin, varved clays and silty sands were laid down in this lake but the lake's duration was short and depositional features associated with it are not extensive.

A major ice retreat associated with a temporary warming of the climate caused the ice to withdraw from part of the Lake Ontario basin and Glacial Lake Iroquois was formed about 12,000 years ago with its outlet down the Hudson Valley. Glacial Lake Iroquois was somewhat larger than present Lake Ontario and its shoreline is a few miles inland from the present shore. This abandoned shoreline of Glacial Lake Iroquois is an important source of sand and gravel in places where bars and spits were built up.

Physiographic Features

The three principal physiographic features in the map-area are:

- (1) The Niagara Escarpment
- (2) The Halton-Peel till plain
- (3) The Lake Iroquois shoreline.

Niagara Escarpment. The Niagara Escarpment occupies a band, a few miles wide, along the western edge of the map-area from Milton to Cheltenham. Detached from the main Escarpment are two outliers: the Milton Heights outlier, and the Glen Williams (Hilltop) outlier. The latter has a scarp of Whirlpool Sandstone along its east side that is extensively quarried for building stone.

On top of the Niagara Escarpment the Pleistocene deposits consist principally of coarse boulder till in the form of a rough, rocky moraine.

A valley cuts through the Niagara Escarpment at Campbellville (southwest of the map-area) forming a prominent re-entrant in the scarp west of Milton where Highway 401 climbs the scarp.

Halton-Peel Till Plain. The area east of the Niagara Escarpment and north of the Lake Iroquois shoreline is occupied by the Halton-Peel till plain. It consists

mainly of bevelled till plain with some fluting. In places it is overlain by thin varved clay or silty sand of Lake Peel.

Drumlins are uncommon but two occur just west of Hornby, near Milton. The till plain is dissected by Oakville Creek, the Credit River, Etobicoke and Mimico Creeks, and the Humber River.

The till plain is crossed at the south by the Trafalgar moraine.

Lake Iroquois Shoreline. The abandoned shoreline of Glacial Lake Iroquois extends in a northeasterly direction across the southeastern part of the map-area from Clarkson to Etobicoke. It has been described by Coleman (1936a, p. 9) as follows:

The shore follows closely the contour of 375 feet at first but gradually rises toward the northeast and approaches the 400-foot contour near Clarkson, where it turns northward toward a sharp bend of the Credit river. The river here has cut its way down 25 feet into grey shale, which has a few feet of boulder clay over it. To the west of the bend, near the Erindale school-house, a bar is seen between 325 and 350 feet. The southern end of it along the river has been cemented to a conglomerate, as may be seen from the Dundas highway [Highway 5]. On the southeast side of the river bend another bar runs for a mile north and south and rises to the 400-foot contour. The first-mentioned bar must have been made in a bay of Lake Iroquois at a low-water stage before the later bar, which cut it off from the main lake, was begun.

For three miles northeast, to Cooksville, the shore is often poorly marked against a slope of weathered shale; but north of the village a bay was cut off by a bar, which was used extensively for ballast by the railway. Another bar runs northeast of Dixie, and a third one pushes in the same direction into the valley of Etobicoke creek forming a bay a mile long. After a vague bit of shore for a couple of miles, a fourth bar forms a bay at Islington in the valley of Mimico creek, after which the shore turns north along the west side of the Humber valley.

At Erindale, an extensive sand and gravel industry has been developed in the gravel bar, but the deposits are now becoming depleted or built over. Sand and gravel deposits along the Iroquois shoreline east of Cooksville are now largely depleted and built over.

Pleistocene Deposits

The principal Pleistocene deposits consist of till plains, moraines, drumlins, outwash plains, spillways, kames, eskers, and lake plains.

Till Plains. The principal till plain in the area is the Halton-Peel till plain, that occupies the area east of the Niagara Escarpment and north of the Lake Iroquois shoreline. The surface varies from gently undulating to rolling and relief is limited. A sheet of clay and silty till, many feet thick, rests on bedrock shale. The till takes on the character of the underlying bedrock: where it overlies red Queenston Shale it is red clay or clay and silt with abundant red shale pebbles; where it overlies the grey Meaford-Dundas Shale it is grey-brown and carries many pebbles of

¹Campbellville is just south of the map-area.

²Oak Ridges is northeast of the map-area.

Meaford-Dundas shale and siltstone. In places the till is overlain by a thin veneer of varved clay laid down in Glacial Lake Peel.

Drumlins. Drumlins are oval hills usually about $\frac{1}{2}$ to $\frac{3}{4}$ mile in length and often not more than $\frac{1}{4}$ mile wide. They stand up 50 to 75 feet above the till plain and are generally composed of silty clay till. Drumlins are rare on the Halton-Peel till plain but two have been recognized north of Milton and west of Hornby. There is a drumlin on top of the Escarpment on the western edge of the map-area in Erin Township.

Moraines. The Trafalgar end moraine passes across the southeastern part of the map-area, running from Streetsville to the Richview area. Its continuation into the Hamilton area is described by Karrow (1963, p. 17). Rough, hummocky, rocky moraine composed of abundant boulders of Amabel Dolomite occurs on top of the Niagara Escarpment south of Speyside (near Highway 25) and west of Terra Cotta.

Outwash and Spillway Deposits. Outwash or spillway gravels are found north and west of Kelso (at the southern boundary of the map-area), in the Campbellville Valley along the edge of the Niagara Escarpment, where meltwaters were confined between the scarp and the glacial ice to the east. These spillway gravels are worked by Sherman Sand and Gravel near Kelso.

The Georgetown glacial spillway extends from Cheltenham to Glen Williams and extensive gravel deposits in this spillway have been worked by Armstrong Brothers Company Limited, Industrial Sand and Gravel Company Limited, and Oriole Block Company.

A buried deposit of outwash sand and fine gravel is quarried by Consolidated Sand and Gravel Limited, $1\frac{1}{2}$ miles west of Woodhill (in the north-central part of the map-area).

Kames. Kames are irregular accumulations of partly sorted glacial debris deposited by meltwater at the edge of the ice. Some kame gravels are associated with the glacial spillways.

Eskers. An esker is a long narrow winding ridge of sand and gravel laid down as a stream deposit by glacial meltwaters flowing through crevasses and channels in or beneath an ice sheet. There is a prominent esker in the Brampton area extending for over 3 miles in a southeasterly direction from Heart Lake to southeast of Nortonville, crossing Highway 7. This esker has been extensively quarried by Armstrong

Brothers Company Limited, Franceschini Brothers Construction Company Limited, J. C. Duff Limited, Salisbury Sand and Gravel (location not shown on Map 2176, back pocket), Gormley Sand and Gravel, Peel Sand and Gravel, and Livingston Sand and Gravel. This esker was overridden by the ice and is capped by till. The esker consists of variable deposits of coarse, medium, and fine gravel with stratified sand and, in places, silt and clay. The deposits show rapid changes in lithology over short distances. Because the glacial river flowed across an area underlain mainly by Meaford-Dundas Shale, there are numerous pebbles of Meaford-Dundas laminated siltstone in the gravels. In places, the siltstone content makes up more than 30 percent of the gravel. Considerable cementation and encrustation is also present in places. The operators produce mainly pit run sand and gravel, fill, and crusher run gravel.

Lake Plains. The principal lake plain is that of Glacial Lake Iroquois lying between the Iroquois beach and the Lake Ontario shore. The lake plain is composed of a veneer of sand and clay over till. The lake plain slopes gently from the Iroquois beach to the present lakeshore. Dundas Shale is exposed along the shore of Lake Ontario in vertical bluffs up to 7 feet high.

The lake plain of Glacial Lake Peel is not well marked but some thin veneers of varved clay and silty sand were probably laid down in this lake. An area of sand, extending along the Credit River from Norval to Huttonsville, in the central part of the map-area, at an elevation of about 700 feet, may mark a delta in Glacial Lake Peel (Peel Ponding), Chapman and Putnam (1951, p. 32). The lack of prominent shore features in Glacial Lake Peel indicates that it was probably not of long duration.

Pleistocene Stratigraphy

Work by A. K. Watt (1968) in Etobicoke Township in the eastern part of the map-area indicates that there are four till sheets present. The oldest one, which rests on bedrock shale, is Illinoian or older in age, and the other three are probably Wisconsinan. Evidence for an interglacial stage in this part of the Toronto area is inconclusive.

Recent Deposits

The recent deposits of the area are mainly composed of alluvial stream deposits of silt, sand, and gravel, and swamp deposits of bog and muck of organic origin. No peat bogs of potential economic interest were found in the area.

ECONOMIC GEOLOGY

The industrial mineral deposits being exploited in the area include the Meaford-Dundas and Queenston Shales, the Whirlpool Sandstone, the Amabel Dolomite, and sand and gravel deposits.

DUNDAS SHALE

Dundas Shale is quarried for brick manufacture at the Ontario Reformatory and Booth Brick Limited in Etobicoke and at the Cooksville plant of Domtar Construction Materials Limited. At the latter plant Dundas Shale is also used for the manufacture of lightweight aggregate under the trade name of "Haydite". The North York plant of Booth Brick Limited uses shale quarried at the Etobicoke plant.

The properties of Dundas Shale are given in an earlier section. Detailed descriptions of the brick plants are given by Guillet (1967).

BOOTH BRICK LIMITED (2)*

Etobicoke Plant

The Etobicoke plant of Booth Brick Limited is located at 320 Horner Avenue, Toronto 14. The annual plant capacity is 20 million bricks in a full range of colours and textures. The quarry exposes 52 feet of dark green-grey, moderately soft, thin- and medium-bedded shale interlayered with a few hard limy and sandy layers. The section belongs to the Humber Member of the Dundas Formation.

BOOTH BRICK LIMITED (3)

North York Plant

The North York plant of Booth Brick Limited is located on Edgar Avenue, a short distance west of the junction of Highways 400 and 401 (MacDonald-Cartier Freeway). The annual plant capacity is 25 million bricks in a full range of colours and textures. Dundas Shale from the Etobicoke plant is mixed with clay quarried at the plant location. The clay pit exposes 15 feet of irregularly varved clay and silt probably deposited in Glacial Lake Peel.

DOMTAR CONSTRUCTION MATERIALS LIMITED (5)

Cooksville Plant

The Cooksville plants of Domtar Construction Materials Limited are located just west of Cooksville on Highway 5, in lots 19 and 20, concession I S, Toronto Township. Brick production began at this

location in 1911. The periodic kiln plant is rated at 60 million bricks per year and the tunnel kiln plant at 24 million bricks per year. The quarry exposes 53 feet of the Humber Member of the Dundas Formation. The quarry is worked in two benches: a lower 20-foot bench, and an upper 33-foot bench. Some hard limy or sandy layers are sorted out and used for building stone.

ONTARIO REFORMATORY (9)

The brick and tile plant of the Ontario Reformatory** is located on Horner Avenue in New Toronto. The annual production is about 3 million bricks and 1 million tiles. A 21-foot face of the Humber Member of the Dundas Shale is quarried.

QUEENSTON SHALE

Queenston Shale is quarried for brick manufacture at Canada Brick Limited and F. B. McFarren Limited in Streetsville, at Brampton Brick Limited in Brampton, and at Milton Brick Limited in Milton. The properties of Queenston Shale are given in an earlier section. Detailed plant descriptions are given by Guillet (1967).

BRAMPTON BRICK LIMITED (1)

The Brampton plant of Brampton Brick Limited is located on Highway 10 on the northern outskirts of Brampton on lot 10, concession I E, Chinguacousy Township. The plant has produced for nearly 80 years. The annual plant capacity is 24 million bricks. The Queenston Shale is worked in two 18-foot benches with about 5 feet of sandy loam overburden being stripped. A 70-foot section of Queenston Shale is exposed in the pit.

CANADA BRICK LIMITED (4)

Streetsville

The Streetsville plant of Canada Brick Limited is located on lot 6, concession V, W.H.S., Toronto Township. The annual plant capacity is over 84 million bricks in a full range of colours and textures. A 25-foot section of Queenston Shale is quarried. Some green beds are sorted out and discarded. Clay is quarried in a 10-foot section just west of the plant.

*Number in brackets refers to property number on Map 2176, back pocket.

**This plant closed October 1968.

DOMTAR CONSTRUCTION MATERIALS LIMITED (6)

Cheltenham Plant

Domtar Construction Materials Limited formerly operated a brick plant at Cheltenham in lot 29, concession IV, Chinguacousy Township. The quarry exposes a 58-foot section of Queenston Shale.

F. B. McFARREN LIMITED (7)

The Streetsville plant of F. B. McFarren Limited is located in lot 3, concession V, W.H.S., Toronto Township. The annual production is about 10 million bricks in a complete range of colours and textures. Three quarries have been opened in a low escarpment west of the plant. One quarry consists of 8 to 10 feet of soft weathered shale; a second quarry consists of 15 feet of red-burning shale; the third and most northerly quarry has a 20-foot face of variegated red and green shale that is red-burning. Limestone is added to produce buff brick. The floors of the two main quarries are 10 to 15 feet above the contact with the grey Meaford Shale.

MILTON BRICK LIMITED (8)

The Queenston Shale quarry of Milton Brick Limited is in lot 1, concession I, Esquesing Township and the plant is adjacent. The annual plant capacity is 30 million bricks in a full range of colours and textures. At the quarry 4 feet of sandy loam is stripped. The main shale production is from three 30-foot benches worked progressively westward into the scarp. A second small quarry is worked in two benches west of the plant. A section of 130 feet of Queenston Shale is exposed in the quarries. The shale contains less than 10 percent green beds and burns light red. One 6-foot section below the main quarry floor consists of 25 percent green shale and burns to a dark buff colour. A 10-foot section of red shale below the buff-burning shale is used mainly for pressed brick and burns to a dark red colour. Guillet (1967, p. 86-90).

TORONTO BRICK COMPANY (10)

Toronto Brick Company operated a Queenston Shale quarry in Milton on lots 14 and 15, concession I NS, Trafalgar Township (now Town of Oakville). The quarry exposes a 30-foot face of Queenston Shale.

WHIRLPOOL SANDSTONE

The Whirlpool Sandstone Formation of Silurian age outcrops along the base of the Niagara Escarpment throughout the map-area. It is a medium-grained, thin- to massive-bedded, grey to red or mottled sandstone. In places it is crossbedded. It varies in thickness from 12 to 14 feet. The Whirlpool Sandstone is widely quarried as a building stone under the trade name of "Credit Valley Sandstone". Many prominent buildings, such as the main block of the Ontario Parliament Buildings, the Royal Ontario Museum, University College, Knox College, Hart House, and the buildings of the University of Western Ontario are built of this attractive and durable stone. An excellent example of the use of split-faced "Credit Valley Sandstone" rubble may be seen at St. Augustine of Canterbury Church on Bayview Avenue, Toronto.

The stone is quarried at Milton, Limehouse, Glen Williams, and Terra Cotta in the Brampton map-area. It is underlain by Queenston Shale and overlain by thin-bedded shaly Manitoulin Dolomite.

WILLIAM R. BARNES COMPANY LIMITED (11)

The William R. Barnes Company Limited operates a quarry on lot 6, concession VI, Nassagaweya Township for the manufacture of silica grit and ganister for iron foundries and steel plants in the Hamilton area. A 6- to 10-foot section of fine-grained, medium-bedded grey Whirlpool Sandstone is exposed in the quarry. It is overlain by up to 10 feet of Manitoulin Dolomite with some interbedded shale.

A chemical analysis of the silica sand produced by crushing the Whirlpool Sandstone from this quarry is shown in Table 8.

CHEMICAL ANALYSIS OF SILICA SAND PRODUCED BY CRUSHING THE WHIRLPOOL SANDSTONE FROM WM. R. BARNES COMPANY QUARRY (11); ANALYSIS BY THE LABORATORY AND RESEARCH BRANCH, ONTARIO DEPT. MINES

Table 8

	Percent
SiO ₂	93.80
Al ₂ O ₃	1.21
Fe ₂ O ₃	0.09
MgO	0.11
CaO	1.90
Na ₂ O	Nil
K ₂ O	0.08
TiO ₂	0.04
L.O.I.*	1.78
Total	99.01

* Loss on ignition.

BROCKTON QUARRY (12)

The Brockton quarry is located on lot 18, concession VI, Esquesing Township (southwest of Georgetown). There are approximately 15 feet of stripping to uncover about 4 feet of quarry stone. The beds are 2 to 16 inches thick and blue-grey to buff in colour. The 6 to 8 feet of sandstone below the quarried section are not quarried. The principal products are coursing stone, flagstone, and copings. The stone is quarried by drill and plug and feather with the occasional use of black powder. In places, the sandstone is overlain by up to 8 feet of dolomite and blue shale. Equipment includes a compressor and drills, fork lift loader, and a guillotine.

COHOON QUARRY (13)

The Cohoon quarry on lot 22, concession V, Esquesing Township is adjacent to the Rice and McHarg quarry and the depth of overburden and rock section is similar.

AUSTIN CORNER'S QUARRY (14)

In 1962, a quarry was opened on lot 27, concession X, Esquesing Township, across the road from the Hilltop quarry. Approximately 10 feet of clay overburden and 13 feet of dolomite and shale must be stripped to expose the sandstone beds. The stone face quarried consists of 8.7 feet of thick- to massive-bedded, fine-grained, buff, grey, and red mottled Whirlpool Sandstone. The upper 3.7 feet of buff sandstone are quarried in two beds and these are the main freestone coursing beds. The lower 5 feet are red and grey mottled and streaked sandstone in which bedding intervals are somewhat variable across the quarry. Ashlar, flagstone, copings, and steps are produced.

Physical properties of a specimen of grey Whirlpool Sandstone from the Corner's quarry are shown in Table 9.

PHYSICAL PROPERTIES OF A SPECIMEN OF GREY WHIRLPOOL SANDSTONE FROM AUSTIN CORNER'S QUARRY (14); AFTER HEWITT 1964b, p. 30-31		
Table 9	Compressive strength, p.s.i.:	maximum 15,075
		minimum 9,950
		average 10,842
	Absorption:	3.11 percent
	Bulk specific gravity:	2.33
	Weight per cubic foot:	145 pounds
	Abrasive hardness:	15.7

CREDIT VALLEY QUARRIES (15)

A small quarry on the east half of lot 30, concession VI, Chinguacousy Township, 1 mile northwest of Terra Cotta, has been operated by A. Zilio for Credit Valley Quarries. There is little or no overburden on the sandstone. An area of 100 by 350 feet has been cleared exposing about 4 feet of thin-bedded, red and grey, fine-grained Whirlpool Sandstone. Bedding is somewhat irregular and much 2-inch random flagstone is produced from thin layers. Vertical joints strike north-south and east-west (Hewitt 1964b, p. 32).

D. HANDY (16)

In 1966, D. Handy operated a sandstone quarry on the farm of Harold Brown on lot 19, concession V, Esquesing Township, 2 miles south of Limehouse. There are two quarry openings 300 feet apart. Six to ten feet of clay overburden are stripped. Seven to nine feet of grey and buff, fine-grained, medium to irregularly bedded Whirlpool Sandstone are exposed in the quarry. Due to irregular bedding and crossbedding much of the stone is not free-splitting and from 5 to 6 feet of top rock, suitable for dry wall or rubble, must be stripped off to obtain 2 to 3 feet of good coursing stone. The main production has been coursing stone suitable for cutting in the guillotine, (Hewitt 1964b, p. 22).

HILLTOP QUARRY, PRIMEAU ARGO BLOCK COMPANY (17)

One of the largest sandstone quarries operated in Ontario was the Hilltop quarry of Primeau Argo Block Company on the southeast side of the road on lot 26, concession X, Esquesing Township (about 5 miles northwest of Georgetown). The quarry closed in 1966. The sandstone beds outcrop along the east edge of a large elongated outlier of Amabel Dolomite and the quarry has been opened for a length of over a ¼ mile in a northerly direction. As the sandstone face was advanced to the northwest, up to 25 feet of dolomite, shale, and clay overburden were stripped.

The northwest face of the quarry exposes 12.5 feet of medium- to thick-bedded, fine-grained grey Whirlpool Sandstone. The beds quarried had the following thicknesses from the top down: 4.3 feet; 1.2 feet; 0.7 foot; 2.3 feet; and 4.0 feet. The southwest quarry face exposes 8.5 feet of sandstone. To remove large mill blocks for sawing, 1-inch holes were drilled completely through the beds on 0.8-foot centres. The stone is mainly grey with some reddish bands. Cross-bedding is uncommon. Mill blocks, ashlar, flagstone,

sills, steps, and copings were produced. Mill blocks were sawn at the Cooksville plant of Primeau Argo Block Company.

Physical properties of specimens of grey Whirlpool Sandstone from this quarry are shown in Table 10.

Table 10		PHYSICAL PROPERTIES OF SPECIMENS OF GREY WHIRLPOOL SANDSTONE FROM HILLTOP QUARRY OF PRIMEAU ARGO BLOCK COMPANY (17); AFTER HEWITT 1964b, p. 28, 30	
Compressive strength, p.s.i.:		maximum	17,500
		minimum	12,650
		average	15,433
Absorption:			2.81 percent
Bulk specific gravity:			2.34
Weight per cubic foot:			146 pounds
Abrasive hardness:			12.5

MARTIN QUARRY (18)

The sandstone quarry formerly operated by Edward Martin is located at the north end of the Hilltop outlier on lot 28, concession X, Esquesing Township. The property consists of 200 acres mainly underlain by the Whirlpool Sandstone. This quarry has been operated since 1929 and the main workings form a cut over 600 feet long and 80 feet wide. Five to six feet of medium-bedded, grey and red mottled, fine-grained Whirlpool Sandstone have been quarried. Six to eight feet of shaly dolomite overburden are stripped to expose the sandstone (Hewitt 1964b, p. 31).

MORGAN STONE COMPANY (19)

In 1966, the Morgan Stone Company operated a sandstone quarry (previously operated as Scott quarry) in lot 17, concession V, Esquesing Township (southwest of Georgetown). Six to ten feet of clay overburden are stripped. Six feet of medium- to thick-bedded, grey to reddish, fine-grained Whirlpool Sandstone are exposed in the quarry, which has a face over 100 feet long in a north-south direction. Beds range from 3 to 36 inches in thickness and are mainly over 8 inches thick. Joints are irregular. Some cross-bedding is present in the northeast corner of the quarry. The stone has good reed and splits well. Holes 5 inches deep are drilled in line to split the heavier beds by plug and feather. Equipment consists of a compressor and drills, a fork lift truck, and a bulldozer. Production is mainly dry wall stone, ashlar, and flagstone (Hewitt 1964b, p. 20, 22).

HARVEY NORTON (20)

A quarry has been opened by Harvey Norton just northeast of the Structural Sandstone quarry (25) on lot 26, concession IX, Esquesing Township. Up to 15 feet of shale and dolomite are stripped to expose 5 feet of grey Whirlpool Sandstone that is quarried for building stone.

RICE AND MCHARG QUARRY (21)

The Rice and McHarg quarry is located on lot 21, concession V, Esquesing Township, ½ mile south of Limehouse. A large area has been quarried out, and the present quarry measures 200 feet by 500 feet, with a face 2 to 4 feet on the east side. The quarry face runs north-south. The stone is flat lying, thin-bedded, fine-grained, grey and buff Whirlpool Sandstone in beds from 2 to 8 inches thick. Bedding is even and regular. Vertical joints run east-west and north-northwest. This quarry yields a large production of coursing stone, flagstone, steps, and copings. The stone has good splitting qualities. This is one of the largest quarries in the area and the percentage of waste is small. Clay overburden is 4 to 6 feet thick.

Physical specifications of grey Whirlpool Sandstone from this quarry are shown in Table 11.

Table 11		PHYSICAL SPECIFICATIONS OF GREY WHIRLPOOL SANDSTONE FROM THE RICE AND MCHARG QUARRY (21); AFTER HEWITT (1964b, p. 23)	
Compressive strength, p.s.i.:		maximum	16,100
		minimum	11,950
		average	13,800
Absorption:			2.99 percent
Bulk specific gravity:			2.33
Weight per cubic foot:			145 pounds
Abrasive hardness:			14.8

S. SKELIN (22)

In 1966, S. Skelin opened a small quarry in Whirlpool Sandstone in lot 15, concession IV, Esquesing Township. Up to 4 feet of thin-bedded grey sandstone are exposed in low ground east of the farmhouse. Flagstone is the principal product.

S. SKELIN (23)

A quarry was opened in 1962 on lot 20, concession VI, Esquesing Township (southeast of Limehouse) by Steve Skelin. About 10 feet of clay till overburden are stripped to expose 7 to 8 feet of grey,

fine-grained, medium- to thick-bedded Whirlpool Sandstone. The upper 2 to 3 feet of heavily bedded sandstone are stripped off. The lower 5 feet of stone are regularly bedded, thin- to medium-bedded, with beds 2 to 9 inches thick. The stone has good reed. The Queenston Shale is exposed in places in the quarry floor. The 5-foot working face has a length of 80 feet. Vertical joints strike northwest (Hewitt 1964b, p. 24).

SMITHSON QUARRY (24)

The Smithson quarry is located on the west half of lot 30, concession VI, Chinguacousy Township, about 1 mile northwest of Terra Cotta. Five to six feet of thin- to medium-bedded, fine-grained, grey and red Whirlpool Sandstone are exposed in the quarry (Hewitt 1964b, p. 31-32). The quarry was not in operation in 1966.

STRUCTURAL SANDSTONE QUARRY (25)

The Structural Sandstone quarry is located on lot 26, concession IX, Esquesing Township (about 4 miles northwest of Georgetown) on the property formerly operated by Industrial Sand and Gravel Company Limited. The quarry opening measures 50 by 100 feet and a considerable thickness of clay and shaly dolomite is stripped to uncover the stone beds. The section observed at the quarry consists of 2 feet of green shale and dolomite underlain by 3.6 feet of buff sandstone, in 6- to 8-inch beds, with shaly partings, followed by 4.5 feet of crossbedded sandstone, 6 inches of buff sandstone, and 3 to 5 feet of good grey coursing stone with good splitting qualities. This is underlain by a 10-inch sandstone bed and shale. The 3- to 5-foot section of stone with good reed yields the main production of building stone (Hewitt 1964b, p. 26). The quarry was not in operation in 1966.

AMABEL DOLOMITE

The Amabel Dolomite forms the cap rock of the Niagara Escarpment and extends along the western margin of the map-area from Milton to Cheltenham. Since the building of Highway 401 (MacDonald-Cartier Freeway) has opened the Kelso area (west of Milton) to easy access to Toronto, three large quarries have opened in the Milton-Kelso area: Milton Quarries Limited (32), Halton Crushed Stone Limited (29), and the Dufferin quarry (28) of Associated Quarries and Construction Limited.

ARMSTRONG BROTHERS COMPANY LIMITED (26)

Georgetown Quarry

The Georgetown quarry of Armstrong Brothers Company Limited, opened during the summer of 1958, is located 3 miles west of Georgetown and ½ mile west of Highway 7, in lot 24, concession VII, Esquesing Township. The quarry was not operated in 1966.

The quarry was worked in two lifts. The upper lift, 24 to 39 feet in height, consists entirely of light grey to light buff, medium-crystalline to aphanitic, medium- to thick-bedded, crinoidal Amabel Dolomite. The dolomite is in part porous and fossiliferous, but reefs are rare. The lower lift was flooded at the time of the author's visit, but conversation with the quarry superintendent and examination of the stone from the lower lift, indicated that the lower 15-foot lift consists of about 10 feet of Amabel Dolomite underlain by about 5 feet of medium grey, aphanitic Reynales Dolomite.

A chemical analysis of a composite chip sample of the upper 20 feet of the upper lift is given in Table 12.

Table 12 | CHEMICAL ANALYSIS OF A COMPOSITE CHIP SAMPLE FROM UPPER 20 FEET OF UPPER LIFT OF ARMSTRONG BROTHERS COMPANY GEORGETOWN QUARRY (26); AFTER HEWITT (1960, p. 121), SAMPLE COLLECTED BY AUTHOR AND ANALYSED BY LABORATORY AND RESEARCH BRANCH, ONTARIO DEPT. MINES

	Percent
SiO ₂	0.64
Al ₂ O ₃	0.39
Fe ₂ O ₃	0.76
MgO	21.20
CaO	30.00
CO ₂	46.42
P ₂ O ₅	0.19
S	0.02
Total	99.62

DOMTAR CHEMICALS LIMITED (27)

Milton Plant and Quarry

The Milton lime plant and quarry of Domtar Chemicals Limited is no longer in operation. It is located on the edge of the Milton Heights outlier south of the Canadian Pacific railway line in lot 3, concessions VI and VII, Nassagaweya Township.

The 60- to 90-foot quarry face exposed along the north-facing scarp consists of light buff to medium light grey, medium-crystalline, thick- to massive-bedded, crinoidal dolomite of the Amabel Formation.

It is in part irregularly bedded, vuggy reef facies. The lower 8 feet of this formation are bluish grey. The floor of the quarry exposes 6 feet of medium grey, mottled, aphanitic, thin- to medium-bedded Reynales Dolomite below the Amabel Formation.

DUFFERIN QUARRY (28)

The Dufferin quarry of Associated Quarries and Construction Limited is located northwest of Milton on lots 9 and 10, concession I, Esquesing Township.

The 50- to 60-foot quarry face consists almost entirely of Amabel Dolomite, which is light buff in colour, buff-weathering, medium to coarsely crystalline, thick- to massive-bedded, porous in part, and highly fossiliferous. A 6-foot section of grey crinoidal dolomite forms the base of the Amabel section. At the base of the quarry face is about 5 feet of grey-green to buff, aphanitic, medium-bedded Reynales Dolomite. This formation also forms the quarry floor and totals about 8 feet in thickness. It is underlain by Thorold Shale or Cabot Head Shale.

Chemical analysis of a sample of 1-inch stone from the stockpile is given in Table 13.

CHEMICAL ANALYSIS OF SAMPLE OF 1-INCH STONE FROM STOCKPILE OF DUFFERIN QUARRY (28); AFTER HEWITT (1964a, p. 51), (SAMPLE COLLECTED BY AUTHOR; ANALYSIS BY LABORATORY AND RESEARCH BRANCH, ONTARIO DEPT. MINES)	
	Percent
SiO ₂	1.30
Al ₂ O ₃	1.54
Fe ₂ O ₃	0.30
MgO	20.94
CaO	29.52
L.O.I.*	47.44
SO ₃	0.12
Total	101.16

* Loss on ignition.

HALTON CRUSHED STONE LIMITED (29)

The quarry of Halton Crushed Stone Limited is 4 miles west of Milton, on top of the Escarpment, in lot 8, concession VI, Nassagaweya Township. The quarry began operations in the summer of 1959. The quarry face exposes 80 to 90 feet of buff to light grey, buff-weathering, medium-crystalline, crinoidal, medium to thick and irregularly bedded, reefy, fossiliferous dolomite. Overburden is variable, ranging from a few inches to several feet in thickness. Grey-green Thorold Shale or Cabot Head Shale is exposed in ditches in the quarry floor. This is overlain by 8 feet

of Reynales Dolomite, which forms the quarry floor (Hewitt 1960, p. 120; 1964a, p. 48-49).

Two chemical analyses of the stone from the Halton quarry are given in Table 14. The first was supplied by the company; the second is a sample of ¾-inch stone from the stockpile, taken by the author.

CHEMICAL ANALYSES OF STONE FROM QUARRY OF HALTON CRUSHED STONE LIMITED (29); AFTER HEWITT (1964a, p. 48-49)		
Table 14	Sample 1*	Sample 2**
	Percent	Percent
SiO ₂	0.59	0.16
Al ₂ O ₃	0.04	0.69
Fe ₂ O ₃	0.46	0.33
CaO	31.08	30.28
MgO	20.59	21.02
S	0.04	n.d.
CO ₂	46.88	47.22
Total	99.68	99.70

* Data supplied by company.

** Sample collected by author from quarry stockpile; analysis by Laboratory and Research Branch, Ontario Department of Mines.

INDUSTRIAL SAND AND GRAVEL COMPANY LIMITED (30)

Glen Williams Quarry

The Glen Williams quarry of Industrial Sand and Gravel Company Limited is located 2 miles northwest of Glen Williams at the south end of the Hilltop outlier in lot 26 or 27, concession IX, Esquesing Township.

The 35-foot quarry face consists of 30 feet of white to light buff, white-weathering, medium-crystalline, massive and irregularly bedded, crinoidal dolomite of the Amabel Formation, underlain by 5 feet of light grey to dark grey streaked, aphanitic, medium-bedded, shaly Reynales Dolomite (Hewitt 1960, p. 122).

The quarry was not in operation in 1966.

LIMEHOUSE CRUSHED STONE AND GRAVEL LIMITED (31)

The quarry of Limehouse Crushed Stone and Gravel Limited is located north of Georgetown on the east side of Highway 7 at Silver Creek, in lot 27, concession VIII, Esquesing Township.

The 15-foot quarry face consists of light buff to light grey, medium-crystalline, medium- to thick-bedded, crinoidal dolomite of the Amabel Formation (Hewitt 1960, p. 121).

The quarry has not been in operation for some years.

MILTON QUARRIES LIMITED (32)

The quarry of Milton Quarries Limited is located on Milton Heights, 1 mile west of Milton, in lot 1, concession VII, Nassagaweya Township. The quarry was opened during the summer of 1958. The quarry face has advanced to the west into the Escarpment and a 65- to 70-foot face of light buff to light grey, medium-crystalline, thick- to massive-bedded Amabel Dolomite is exposed. About 4 feet of mottled blue-grey, aphanitic, medium-bedded Reynales Dolomite are exposed at the base of the quarried section and this rock forms the quarry floor. The Reynales Dolomite ranges from 7 to 10 feet in thickness.

In the lower 6 feet of the quarry face the typical buff, medium-crystalline, crinoidal dolomite of the Amabel Formation is streaked and mottled with tones of grey. This zone of colour mottling may represent the Gasport Equivalent. Rare bioherms were observed in places in the quarry face, with beds showing typical off-reef dips. (See Hewitt 1960, p. 119; 1964a, p. 47.)

A chemical analysis of a sample of 2-inch stone from the stockpile was supplied by the company and is shown in Table 15.

Table 15

CHEMICAL ANALYSIS OF A SAMPLE OF 2-INCH STONE FROM THE STOCKPILE OF MILTON QUARRIES LIMITED (32), ANALYSIS SUPPLIED BY THE COMPANY; AFTER HEWITT 1964a, p. 47

	Percent
SiO ₂	1.84
Al ₂ O ₃	0.67
Fe ₂ O ₃	0.59
CaO	32.26
MgO	17.67
S	0.14
P	0.001
L.O.I.*	46.60
Total	99.77

* Loss on ignition.

SAND AND GRAVEL

Types of sand and gravel deposits encountered in the Brampton area include eskers, kames, spillways, outwash, beaches, and deltas. These types of deposits are described in Hewitt and Karrow (1963, p. 17-33). Thirty-one sand and gravel pits are shown on the Brampton map (Map 2176, back pocket) but not all are described in this report.

ACE SAND AND GRAVEL (33)

A gravel pit was formerly operated by Ace Sand and Gravel on lot 13, concession III W, Toronto Township, 4 miles south of Brampton. The deposit consists of a shallow gravel terrace, 4 to 6 feet thick, resting on clay. It appears to be an imbricated beach gravel containing some sand. Pebbles of limestone, siltstone, and red shale were noted. A portable plant was employed to produce crusher-run gravel.

ALREX SAND AND GRAVEL (34)

The Silver Creek pit of Alrex Sand and Gravel was formerly operated on lot 27, concession VII, Esquesing Township. It is described by Hewitt and Karrow (1963, p. 55).

ARMSTRONG BROTHERS COMPANY LIMITED (36)

Glen Williams

The Armstrong Brothers' Glen Williams pit is on lot 24, concession XI, Esquesing Township in the Georgetown spillway. It is described by Hewitt and Karrow (1963, p. 54).

BEE JAY SAND AND GRAVEL (38)

Glen Williams

A sand deposit formerly operated at Glen Williams by Bee Jay Sand and Gravel is described (under Bee Jay Sand and Gravel, Terra Cotta) by Hewitt and Karrow (1963, p. 65).

BEE JAY SAND AND GRAVEL (39)

Terra Cotta

A sand pit formerly operated by Bee Jay Sand and Gravel is on lot 27, concession V, Chinguacousy Township. It is described by Hewitt and Karrow (1963, p. 64).

BRAMPTON ESKER

North of Brampton, a partly buried esker extends northwest for a distance of over 3 miles, from Nortonville on Highway 7, to Heart Lake. The esker consists of variable deposits of coarse, medium, and fine gravel with stratified sand and, in places, silt and clay. The deposits, having been laid down by a stream within or beneath the ice sheet, are extremely variable and show rapid changes of lithology over short

distances. Because the stream flowed across an area underlain mainly by the Meaford-Dundas Shale, numerous pebbles of laminated siltstone are found in the gravels. In places, siltstone constitutes more than 30 percent of the gravel. A considerable amount of cementation and encrustation is also present in places (Hewitt and Karrow 1963, p. 59).

The following eight sand and gravel pits occur from southeast to northwest in the Brampton esker; their locations are shown on Map 2176 (back pocket):

Chassels pit (41)

Gormley Sand and Gravel (50)

J. C. Duff Limited (46)

Franceschini Bros. Construction Co. Ltd. (47)

Armstrong Bros. Co. Ltd. (37)

Livingston Sand and Gravel (53)

Armstrong Bros. Co. Ltd. (Donnelly pit) (35)

Peel Sand and Gravel (58)

Most of these pits are described by Hewitt and Karrow (1963, p. 60-63).

Peel Sand and Gravel (58)

The only new pit to be opened since 1962 is that of Peel Sand and Gravel at the north end of the esker. A 30-foot face exposes stratified sand with patchy gravel. Pebbles up to 4 inches in size occur, but only 30 percent of the pebbles in the gravel exceed 1 inch in size.

BROOKS PIT (40)

The gravel pit, on the farm of Fred Brooks in lot 23, concession V, Esquesing Township (west of Limehouse), is described by Hewitt and Karrow (1963, p. 55).

CLARKSON SAND AND GRAVEL (42)

The Clarkson Sand and Gravel pit is located about 1 mile south of Erindale. The operation of this pit is described by Hewitt and Karrow (1963, p. 57).

CONNOR TRANSPORT LIMITED (43)

North of the Brooks pit, probably in lot 24 or 25, concession V, Esquesing Township, are two gravel pits operated in 1966 by Connor Transport Limited. In one pit, a 25-foot face exposes stratified sand and gravel composed of about 60 percent stone and 40 percent sand. The maximum size of boulders is 12 inches, with 40 percent of the pebbles exceeding 4 inches in size, and 70 percent exceeding 1 inch in size. The second pit is in sand.

CONSOLIDATED SAND AND GRAVEL LIMITED (44)

Malton

The Malton pit and plant of Consolidated Sand and Gravel Limited are located on lot 10, concession V, Chinguacousy Township. The property is 6 miles northwest of Malton and 1½ miles north of Highway 7 at the northern boundary of the map-area.

The glaciofluvial outwash deposit consists of well sorted, well stratified sand containing minor inter-stratified fine to medium gravel. The outwash deposit was overridden by till and was buried beneath a till sheet (Hewitt and Karrow 1963, p. 64).

CONSOLIDATED SAND AND GRAVEL LIMITED (45)

Stewartown

The Stewartown pit (southwest of Georgetown) of Consolidated Sand and Gravel Limited is described by Hewitt and Karrow (1963, p. 55).

FRANCESCHINI BROTHERS CONSTRUCTION COMPANY LIMITED (48)

Britannia

Franceschini Brothers Construction Company Limited operate a sand pit on the farm of Stewart Scott on lot 2, concession I E, Toronto Township, about 6 miles south of Malton. A 25-foot face exposes well stratified fine sand, but no gravel. The material is mainly used for sand fill. A sieve analysis of the sand is given by Hewitt and Karrow (1963, p. 60).

FRANCESCHINI BROTHERS CONSTRUCTION COMPANY LIMITED (49)

Erindale

Franceschini Brothers operated a gravel pit on the west side of the Credit River just northwest of Erindale, on the east side of the Streetsville Road. This gravel deposit is a beach deposit similar to those on Springbank Road to the south. The pit has an uneven floor of Dundas Shale. The 15- to 25-foot face exposes stratified gravel, sand, and silt. One section examined is 80 percent gravel and 20 percent sand. Twenty percent of the gravel exceeds 4 inches in size, and sixty percent exceeds 1 inch. Long flat slabs of siltstone are common. There is considerable cementation of the gravel. Sieve analysis of the sand, a pebble count, and mineralogical analysis of the sand are given by Hewitt and Karrow (1963, p. 56).

W. R. GREENLEY CONSTRUCTION COMPANY (51)

A gravel pit formerly operated by W. R. Greenley Construction Company on lot 19, concession VII, Esquesing Township (southwest of Georgetown), is described by Hewitt and Karrow (1963, p. 54-55).

INDUSTRIAL SAND AND GRAVEL (52)

A gravel pit on lot 23, concession X, Esquesing Township, in the Georgetown spillway, was formerly operated by Industrial Sand and Gravel. It is described by Hewitt and Karrow (1963, p. 54).

**LOT 5, CONCESSION VIII,
ESQUESING TOWNSHIP (54)**

A small sand pit has been opened in lot 5, concession VIII, Esquesing Township. The pit has not been worked recently and is badly slumped. It is capped by several feet of till.

LOT 11, CONCESSION IV, ESQUESING TOWNSHIP (55)

A sand pit has been opened in lot 11, concession IV, Esquesing Township. A 20-foot face exposes stratified fine sand. A sieve analysis of a sample of the sand is shown in Table 16.

**MINERAL INDUSTRIES SAND
AND GRAVEL LIMITED (56)**

A gravel pit was formerly operated by Mineral Industries Sand and Gravel Limited on lot 3 or 4, concession II E, Toronto Township, about 5 miles south of Malton. The gravel forms a beach deposit resting on Dundas Shale bedrock. Many of the pebbles are flattened and imbricate structure is developed. A 15-foot face exposes 50 percent gravel and 50 percent sand. The maximum size of stone is 10 inches; 40 percent exceeds 4 inches and 60 percent exceeds 1 inch. Shale and siltstone pebbles are present in the gravel (Hewitt and Karrow 1963, p. 59).

ORIOLE BLOCK COMPANY (57)

A gravel pit formerly operated by Oriole Block Company near Glen Williams is described by Hewitt and Karrow (1963, p. 54).

PEEL SAND AND GRAVEL (58)

This property is discussed in the section on the "Brampton Esker".

R. PINCHIN (59)

The Pinchin gravel pit in the Erindale bar is described by Hewitt and Karrow (1963, p. 59).

SHERMAN SAND AND GRAVEL LIMITED (60)**Clarkson**

The plant and pits of Sherman Sand and Gravel are in the Erindale gravel bar of Glacial Lake Iroquois. The plant is at the intersection of Springbank Road and Mississauga Road, ½ mile north of the Queen Elizabeth Way. The gravel pits are on lots 12 and 13, range 3 CIR. The beach deposit of stratified gravel and coarse sand is exposed in a 20-foot face in the proportion of 50 percent stone and 50 percent sand. There are 2 to 4 feet of stripping. Pebbles are flattened and imbricate structure is common. Further information on the deposit and plant is given by Hewitt and Karrow (1963, p. 55-57).

SHERMAN SAND AND GRAVEL (61)**Glen Williams**

A deposit of well stratified fine sand has been opened by Sherman Sand and Gravel in lot 21, concession X, Esquesing Township. The 25-foot face exposed consists entirely of sand. A sieve analysis of a sand sample from the face is shown in Table 17.

Table 16

SIEVE ANALYSIS OF SAND FROM LOT 11, CONCESSION IV, ESQUESING TOWNSHIP (55);
ANALYSIS BY LABORATORY AND RESEARCH BRANCH, ONTARIO DEPT. MINES

Mesh	+4	-4 +8	-8 +14	-14 +28	-28 +48	-48 +100	-100 +200	-200
Weight Percent	Nil	Nil	Nil	Nil	1.55	74.6	19.5	4.35

Table 17 | SIEVE ANALYSIS OF SAND FROM SHERMAN SAND AND GRAVEL'S GLEN WILLIAMS PIT (61); ANALYSIS BY LABORATORY AND RESEARCH BRANCH, ONTARIO DEPT. MINES

Mesh	+4	-4 +8	-8 +14	-14 +28	-28 +48	-48 +100	-100 +200	-200
Weight Percent	0.5	0.55	0.5	2.25	32.65	52.7	7.25	3.6

Table 18 | SIEVE ANALYSIS OF SAND FROM SHERMAN SAND AND GRAVEL'S HUTTONSVILLE PIT (62); ANALYSIS BY LABORATORY AND RESEARCH BRANCH, ONTARIO DEPT. MINES

Mesh	+4	-4 +8	-8 +14	-14 +28	-28 +48	-48 +100	-100 +200	-200
Weight Percent	2.1	2.05	3.9	7.05	18.45	32.45	27.0	7.0

SHERMAN SAND AND GRAVEL (62)

Huttonsville

A small sand pit is operated by Sherman Sand and Gravel on lot 5, concession V, Chinguacousy Township, at Huttonsville, in the deltaic sand of Glacial Lake Peel. A 10-foot face exposes fine sand with some clay and silt. A sieve analysis of the sand is shown in Table 18.

SHERMAN SAND AND GRAVEL (63)

Kelso

At Kelso, on the north side of the Campbellville Road, a deposit of kame gravel is worked by Sherman Sand and Gravel. This is part of a thick sheet of kame and spillway gravels laid down at the base of the Escarpment.

REFERENCES

- Bolton, T. E.
1957: Silurian stratigraphy and palaeontology of the Niagara Escarpment in Ontario; Geol. Surv. Canada, Memoir 289, 145 p., accompanied by a map, charts and a book of plates.
- Caley, J. F.
1940: Palaeozoic geology of the Toronto-Hamilton area, Ontario; Geol. Surv. Canada, Memoir 224, 284 p., accompanied by Map 584, scale 1 inch to 4 miles, and Map 585A, scale 1 inch to 2 miles.
- Chapman, L. J., and Putnam, D. F.
1951: The physiography of southern Ontario; University of Toronto Press, 284 p., accompanied by 4 maps.
- Coleman, A. P.
1932: The Pleistocene of the Toronto region; Ontario Dept. Mines, Vol. 41, pt. 7, 69 p. (published 1933). Accompanied by Map 41g, scale 1 inch to 1 mile.
1936a: Lake Iroquois; Ontario Dept. Mines, Vol. 45, pt. 7, p. 1-36. Accompanied by Map 45f, scale 1 inch to 5 miles.
1936b: Geology of the north shore of Lake Ontario; Ontario Dept. Mines, Vol. 45, pt. 7, p. 37-74.
- Guillet, G. R.
1967: The clay products industry of Ontario; Ontario Dept. Mines, Ind. Mineral Rept. 22, 206 p. Accompanied by Maps 2130 and 2131, scale 1 inch to 16 miles.
- Hewitt, D. F.
1960: The limestone industries of Ontario; Ontario Dept. Mines, Ind. Mineral Circ. 5, 177 p. Accompanied by: Map 1960c, scale 1 inch to 20 miles; Map 1960d, scale 1 inch to 1 mile; and charts.
1964a: The limestone industries of Ontario, 1958-1963; Ontario Dept. Mines, Ind. Mineral Rept. 13, 77 p. Accompanied by Map 2059, scale 1 inch to 16 miles.
1964b: Building stones of Ontario, pt. IV, sandstone; Ontario Dept. Mines, Ind. Mineral Rept. 17, 57 p.
- Hewitt, D. F., and Karrow, P. F.
1963: Sand and gravel in southern Ontario; Ontario Dept. Mines, Ind. Mineral Rept. 11, 151 p. Accompanied by Maps 2038, 2039, 2040, 2041, and 2042, scale 1 inch to 16 miles.
- Hoffman, D. W., and Richards, N. R.
1953: Soil survey of Peel County; Ontario soil survey Rept. No. 18.
- Karrow, P. F.
1963: Pleistocene geology of the Hamilton-Galt area; Ontario Dept. Mines, Geol. Rept. 16, 68 p. Accompanied by Maps 2029, 2030, 2033, and 2034, scale 1 inch to 1 mile.
- Watt, A. K.
1968: Pleistocene geology and ground water resources, Township of Etobicoke; Ontario Dept. Mines, Geol. Rept. 59, 50 p. Accompanied by Map 2111, scale 1 inch to ½ mile, and 3 charts.

INDEX

	PAGE		PAGE
Access	2	Cabot Head Shale and Sandstone	5, 6, 14
Ace Sand and Gravel:		Calcareous sandstone	3, 6
Toronto Tp., con. III, lot 13	5	Calcite	4
Acknowledgments	3	Campbellville	7
Acton:		Campbellville Road	18
Amabel Dolomite near	6	Campbellville Valley	8
Acton Limestone Quarries Ltd.	1	Canada Brick Ltd.	2, 5, 9
Aggregate, concrete	6	Carbonaceous material	4
Albemarle Group	6	Carbonate rocks	5
Alrex Sand and Gravel:		Cataract Group	1, 5
Esquesing Tp., con. VII, lot 27	15	Cenozoic rocks	6
Amabel Dolomite	6, 8, 9, 14	Ceramic properties:	
In Nassagaweya Tp.	15	Notes and table	4
In Niagara Escarpment	1, 13	Chassel pit	16
Thickness of	6	Cheltenham, quarries near	2, 5, 8, 13
Amabel Formation:		Chemical composition of shale:	
<i>See:</i> Amabel Dolomite.		Dundas Shale, notes and table	4
Analyses, chemical:		Queenston Shale, notes and table	5
Dundas Shale	4	Chinguacousy Tp., quarries	1, 9-18 <i>passim</i>
Queenston Shale	5	Con. IV, lot 29	10
Samples from:		Con. V, lots 5, 10, 27	15, 16, 18
Armstrong Bros. Co. Ltd. quarry	13	Con. VI, lot 30	13
Barnes, Wm. R., quarry	10	Claireville dam	2
Dufferin quarry	14	Clarkson	1, 2, 7, 17
Halton Crushed Stone	14	Clarkson Sand and Gravel pit	16
Milton Quarries Ltd.	15	Clay	4, 13, 15
Silica sand	10	Thickness of	12
Analyses of ceramic properties, table	4	Till	2
Analyses of physical properties:		Varved	7, 8
Whirlpool Sandstone	5, 11, 12	Clinton Group	1, 6
Analyses, sieve:		Cohon quarry	11
Samples from:		Colour phases in rocks:	
Esquesing Tp., con. IV, lot 11	17	Dolomite	13
Franceschini Bros. Const. Co. Ltd.	16	Sandstone	6
Glen Williams pit	18	Shale	4, 6, 7, 11, 13
Huttonsville pit	18	Colpoy Bay Member:	
Armstrong Bros. Co. Ltd.	8	Of Amabel Formation	6
Brampton esker	16	Concrete aggregate	6
Building stone	1	Conglomerate	7
Georgetown quarry	6, 13	Connor Transport Ltd.	16
Glen Williams pit	15	Consolidated Sand and Gravel pits	8, 16
Ashlar coursing stone	5, 11, 12	Cooksville	1, 7
Associated Quarries and Const. Ltd.:		Domtar Const. Materials Ltd.	2, 8
Dufferin quarry	6, 13, 14	Primeau Argo Block Co.	12
Austin Corner's quarry	5, 11	Cooksville Creek	2
Barnes, Wm. R., Ltd.	5, 10	Cooksville quarry	3
Beach deposits	17	Copings	11, 12
Beaches, abandoned	15	Coursing stone	5, 11, 12, 13
Beach gravel	15	Credit Member:	
Bee Jay Sand and Gravel	15	Of Dundas Shale	3
Bioherms	15	Credit River	2, 7, 8, 16
Booth Brick Ltd.	2, 3, 4, 9	Credit Valley Quarries	11
Brampton Brick Ltd.	2, 5, 9	"Credit Valley Sandstone"	5, 10
Brampton esker	2, 15, 16	Crushed stone production, table	2
Brick and tile plants, note	3	Danforth Member:	
Brick and tile production, table	2	Of Dundas Shale	3
Britannia sand pit	16	Deltas	15
Brockton quarry	5, 11	Dixie	2, 7
Brooks, Fred, farm:		Dolomite	11, 12
Gravel pit on	16	Fossiliferous	6, 13, 14, 15
Brooks pit	16	Shaly	13
Brown, Harold, farm:		Domtar Chemicals Ltd.	13
Sandstone quarry	11	Domtar Const. Materials Ltd.:	
Bruce Peninsula	6	Cheltenham plant	10
Building stone	4, 12, 13	Cooksville plant	2, 3, 4, 9
Brampton area	2	Milton quarry	6
Cheltenham	5	Drainage	2
Milton	1	Drumlins	7, 8
Whirlpool Sandstone for	10	Drumquin	2
Burlington	1	Dry wall stone	5, 12
		Duff, J. C., Ltd.	8, 16

Dufferin quarry	1, 6, 13, 14
Dundas	6
Dundas limestone	3
Dundas Shale	2, 3-4, 8, 9, 16, 17
Economic geology	9
Eramosa Member:	
Of Amabel Formation	6
Erindale	1, 2
Gravel bar	17
Sand and gravel industry	7, 15, 16
Erin Tp.	1, 8
Eskers	7, 8, 15
Esquesing Tp., properties	1, 10-17 <i>passim</i>
Con. I, lots 9, 10	14
Con. IV, lots 11, 15	12, 17
Con. V, lots 21, 24 or 25	12, 16
Con. VI, lot 20	12
Con. VII, lots 19, 24	13, 17
Con. VIII, lots 5, 27	14, 17
Con. IX, lot 26	13
Con. X, lot 23	17
Etobicoke	1, 7, 9
Etobicoke Creek	2
Etobicoke Tp.	1, 3
Flagstone	5, 11, 12
Fletchers Creek	2
Fossiliferous dolomite	6, 13, 14, 15
Franceschini Bros. Const. Co. Ltd.	8, 16
Ganister	10
Gasport Equivalent	15
Geology:	
Economic	9-18
Paleozoic	3-6
Pleistocene	6-8
Georgetown	1, 12
Quarries near	6, 13, 14
Georgetown spillway	2, 7, 8, 15, 17
Glacial history	6
Glacial lakes:	
Lake Iroquois	2, 7, 8
Lake Peel	8, 9
Glacial spillway	7
Glaciofluvial deposit	16
Glen Williams	1, 4
Georgetown spillway near	2, 8
Hilltop outlier near	7
Sand and gravel pits near	6, 14, 15, 17
Whirlpool Sandstone near	10
Gormley Sand and Gravel	8, 16
Gravel bar, Lake Iroquois shoreline	1, 17
Gravel deposits	1, 8, 15, 16, 17
Gravel pits	16, 17
Gravel plant	17
Gravel terrace	15
Greenley, W. R., Const. Co.	17
Grimsby facies rocks	6
Gypsum	5
Gypsum Lime and Alabastine Co.	6
Halton Crushed Stone Ltd.	1, 6, 13, 14
Halton-Peel till plain	7, 8
Halton quarry	14
Hamilton area, moraines	8
Handy, D.:	
Sandstone quarry	5, 11
“Haydite”	2, 9
Heart Lake	8, 15
Hilltop outlier	12, 14
Hilltop quarry	5, 11-12
Hornby	7, 8
Humber Member:	
Of Dundas Shale	3, 9

Humber River	2, 7
Humber Valley	7
Huttonsville	2, 8
Illinoisan glacial stage	6, 8
Industrial mineral deposits	9-18
Industrial mineral production	1, 2
Industrial Sand and Gravel Co. Ltd.	1, 6, 8, 14
Inglewood quarries	5
Iroquois beach (abandoned)	2, 8
Iroquois shoreline (abandoned)	7
Kame gravels	8, 18
Kames	7, 8, 15
Kelso	8, 13, 18
Kilns, brick	6
Lake Iroquois	2, 7
Lake Iroquois shoreline (abandoned)	7
Lake Ontario	2, 8
Ice lobe	7
Lake Peel (glacial)	7, 8
Lake plains	7, 8
Limehouse	10, 11
Limehouse Crushed Stone and Gravel Ltd.	1, 6, 14
Lime plant	13
Limestone	3, 10, 15
Lions Head Member:	
Of Amabel Formation	6
Livingston Sand and Gravel	8, 16
Lockport Dolomite	6
McFarren, F. B., Ltd.	2, 3, 5, 9, 10
Malton, pits near	1, 16, 17
Manitoulin Dolomite	5, 10
Mapping, notes	1, 3
Maps	<i>back pocket</i>
Martin, Edward:	
Sandstone quarry	5, 12
Martin quarry	12
Meaford-Dundas Shale	3-4, 7, 16
Age of, theory	2
Industrial minerals in	9
Varved clay near	8
Meaford-Dundas siltstone	8
Meaford Shale	3, 10
Metropolitan Toronto	1
Middle Oakville Creek	2
Mill blocks	12
Milton	1
Amabel Dolomite near	13
Fossiliferous dolomite near	6
Halton-Peel till plain near	8
Milton Brick Ltd.	2, 9, 10
Quarries near	14
Milton Brick Ltd.	2, 9, 10
Milton Heights	6, 15
Outlier near	7, 13
Milton Heights outlier	7, 13
Milton-Kelso area, quarries	13
Milton Quarries Ltd.	1, 6, 13, 15
Mimico Creek	2, 7
Mineral deposits, industrial	9-18
Mineral Industries Sand and Gravel Ltd.	17
Mineral production, notes and table	2
Mississauga Road	17
Moraines	7, 8
Morgan Stone Co.	5, 12
Mount Charles	2
Nassagaweya Tp., properties	1, 10-15 <i>passim</i>
Con. VI, lots 3, 8	13, 14
Con. VII, lots 1, 3	13, 15
Nelson Tp.	1
New Toronto	9

	PAGE		PAGE
Niagara Escarpment	1, 3	Silica grit	10
Amabel Dolomite in	8, 13	Sills	12
Cabot Head Shale and Sandstone in	5, 6	Siltstone	8, 16, 17
Clay soil near	4	Silurian rocks	1, 4-5, 10
Glacial spillways near	7, 18	See also: Albemarle Group; Cataract Group;	
Quarry in	14	Clinton Group.	
Whirlpool Sandstone in	10	Silver Creek	14
Niagara Falls	6	Silver Creek pit	15
Norton, Harvey:		Skelin, S., quarries	5, 12-13
Sandstone quarry	5, 12	Smithson quarry	13
Nortonville, esker near	8, 15	Speyside	8
Norval	8	Spillway deposits	8
Oak Ridges moraine	7	Spillway gravels	8, 18
Oakville	1	Spillways	7, 15
Oakville Creek	2, 7	Springbank Road:	
Oakville Reformatory:		Gravel plants	16, 17
Brick plant	2, 3, 4	Steps, stone for	11, 12
Production	9	Stewartown pit	16
Ordovician rocks	1, 2, 3	Streetsville	1
See also: Dundas Shale; Queenston Shale.		Brick plant in	9
Oriole Block Co.	8, 17	Quarries near	3
Outwash deposits	8	Queenston Shale near	2, 4
Outwash plains	7	Trafalgar end moraine near	8
Paleozoic geology	3-6	Streetsville Road, gravel pit	16
Peel County	3	Structural Sandstone quarry	13
"Peel ponding"	7	Summerville	2
Peel Sand and Gravel	8, 16	Terra Cotta	1, 4, 8, 10
Physical properties:		Bee Jay Sand and Gravel	15
Whirlpool Sandstone	5, 11, 12	Smithson quarry	13
Pinchin, R., gravel pit	17	Thorold Formation	6, 14
Pits, sand and gravel	15-18	Thorold Shale	6, 14
Pleistocene deposits	2, 6, 7	Till plains	7
Pleistocene geology	6-9	Topography	2
Pleistocene stratigraphy	8	Toronto, Metropolitan	1
Port Credit	1	Toronto Brick Co. Ltd.	2
Primeau Argo Block Co.	5, 11-12	Toronto Gore Tp.	1
Quarries	9-15	Toronto Tp.	1, 9-17 <i>passim</i>
Quartzose sandstone	5	Mapping, notes on	3
Queenston Shale	2, 3-5, 7, 9-10, 13	Meaford-Dundas Shale in	2
Recent deposits	8	Trafalgar end moraine	7, 8
Reynales Dolomite	6, 13, 14, 15	Trafalgar Tp.	1, 10
Rice and McHarg quarry	5, 11, 12	Utilization of:	
Richview	8	Dundas Shale	4
Road stone	6	Queenston Shale	5
Rosedale Member:		Varved clay	7, 8, 9
Of Dundas Shale	3	Waterdown	6
St. Clement's Anglican Church:		Watt, A. K.:	
Building stones of	4	Of Ontario Water Resources Commission	3
Salisbury Sand and Gravel	8	Whirlpool Formation	10
Sand and gravel	15-18	Whirlpool Sandstone	7, 9, 11, 12, 13
Deposits	9	At Glen Williams	1
Industry	7	Physical properties of	5, 11, 12
Production, table	2	Quarries	3
Sandstone	2, 11, 13	Silurian age	4
Calcareous	3, 6	Warton	6
Scott, Stewart, farm	16	Wisconsinan rocks	6, 8
Shale	11, 12, 17	Woodhill kame (buried)	2
Fissile	4	York Tp.	1
See also: Dundas Shale; Queenston Shale.		Zilio, A.	5, 11
Sheridan	2		
Sherman Sand and Gravel	8, 17, 18		

INDUSTRIAL MINERAL REPORT 23

Geological Maps

Map 2176 (coloured)—Brampton Area, southern Ontario, Industrial Mineral Resources Sheet, southern Ontario. Scale, 1 inch to 1 mile.

Map 2179 (coloured)—Brampton Area, southern Ontario, Drift Thickness Map. Scale, 1 inch to 1 mile.

